Space Weather Technical Forecast

Issued on Monday, 14 March 2022 at 12:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor geomagnetic storms on Day 1 (14 Mar), slowly declining. Chance of M-class flares. Chance of Active fluence by Days 3 and 4 (16-17 Mar).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate over the past 24 hours, with an M2 flare at 14/0840 UTC from AR2965. There are currently five sunspot regions on the visible disc. The largest and most complex of these is AR2965, which has recently developed a small delta spot. AR2960 is large but stable, and will be rotating off the Earth-side of the disc towards the end of Day 2 (15 Mar). The other regions are all small and simple. There is one slow weak CME observed on 13 March which may give a glancing blow at Earth.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, showed the effects of a CME which arrived at 13/1014 UTC. Solar wind speeds started the period around 500 km/s and have since declined to around 420 km/s. Density started above average, peaking at 43ppcc at 13/1344 UTC, before declining somewhat through the period. The IMF, Bt, started moderate and soon become strong, with a peak of 25nT around 13/1700-1800 UTC. The north-south component, Bz, varied strongly between +/-24 nT, but settled strongly positive at 13/2240 UTC. Phi angle was variable through this period. Geomagnetic activity reached G1 to G2/Minor to Moderate Storm intervals (Kp 5-6) between 13/1200-14/0300, but has been Quiet to Unsettled since then.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at background levels throughout. The high energy electron flux (greater than 2 MeV) reached moderate levels at the diurnal peak on 13 March, but has been at background levels since. The 24-hour integrated electron fluence was below the Active (1e8 integrated pfu) threshold. Observed fluence at 14/0000 UTC was 4.59e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be mainly Low, perhaps Moderate, with a chance of M-class flares. The risk of M-flares mainly comes from AR2965, especially since it has recently developed a small delta spot.

Solar Wind / Geomagnetic Activity: Ongoing CME effects are expected to gradually decline through Day 1 into Day 2 (14-15 Mar). There is a risk of further periods of negative Bz, although it is currently strongly positive. There is also a slight chance of a glancing blow from a weak CME on Day 4 (17 Mar). No coronal hole effects are currently expected during this period. Geomagnetic activity is expected to be Quiet to Active, with a chance of further G1/Minor Storm intervals if we do see any further periods of negative Bz. The risk of G1 intervals declines through Day 2, with mainly Quiet activity returning, although there is a very slight chance of an increase in activity if we do see the weak CME on Day 4.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain predominantly at background levels, although there is just a very slight

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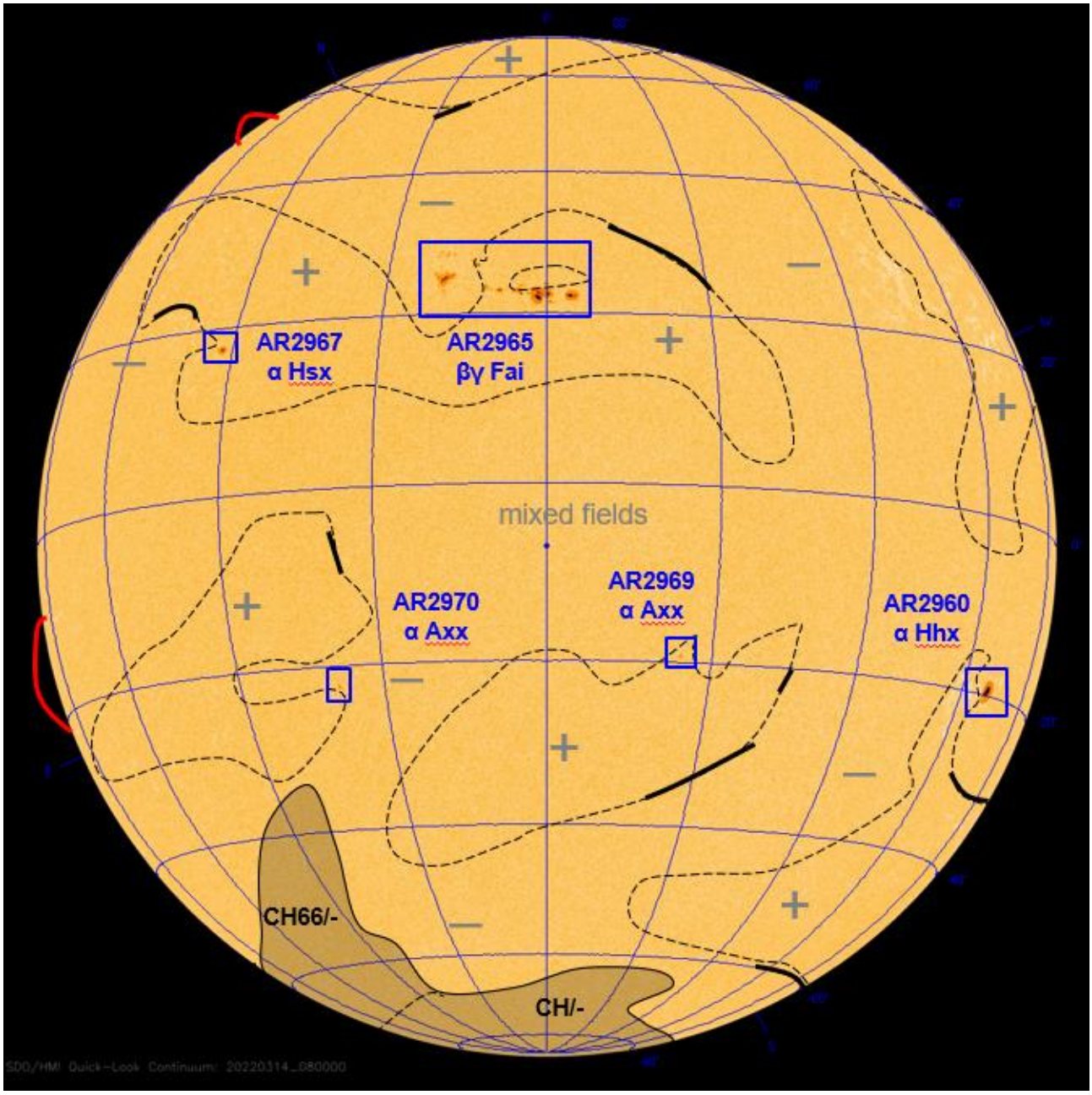
chance of an increase in response to any larger flares that may occur.
The high energy (greater than 2 MeV) electron flux is currently at background levels. Some charging may have occurred from the recent CME, so a rise in electron levels is possible from Day 2 (15 Mar) onwards, with some uncertainty as to the level of any charging. The electron fluence is likely to follow a rising trend if we see an electron response, with a chance of reaching the Active (1e8 integrated pfu) threshold on Days 3 and 4 (16-17 Mar).

Figure 1. Solar Analysis Valid 14/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME arrival occurred yesterday, reaching L1 at 13/1014 UTC. This was likely the arrival of the large halo CME emitted by the long duration C-class flare from ex-AR2962 on the 10th, but perhaps incorporates some element from a filament eruption on the 9th March. Solar wind speeds are currently slightly elevated, with the CME effects expected to gradually decline through Day 1 into Day 2 (14-15 Mar). The magnetic flux rope of the CME could potentially bring further periods of negative (southward) orientation, although Bz is currently strongly positive. There is also a slight chance of a glancing blow from a weak CME on Day 4 (17 Mar), but the bulk of the ejecta is expected to pass below Earth. No coronal hole effects are currently expected during this period.

Geomagnetic activity is expected to be Quiet to Active, with a chance of further G1/Minor Storm intervals if we do see any further periods of negative Bz. The risk of G1 intervals declines through Day 2, with mainly Quiet activity returning, although there is a very slight chance of an increase in activity if we do see the weak CME on Day 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	20	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0406	Full	C5-flare and filament	23N 11W	577	13/2200 UTC	Arrived 13/1014 UTC.
*	*	*	*	*	*	*

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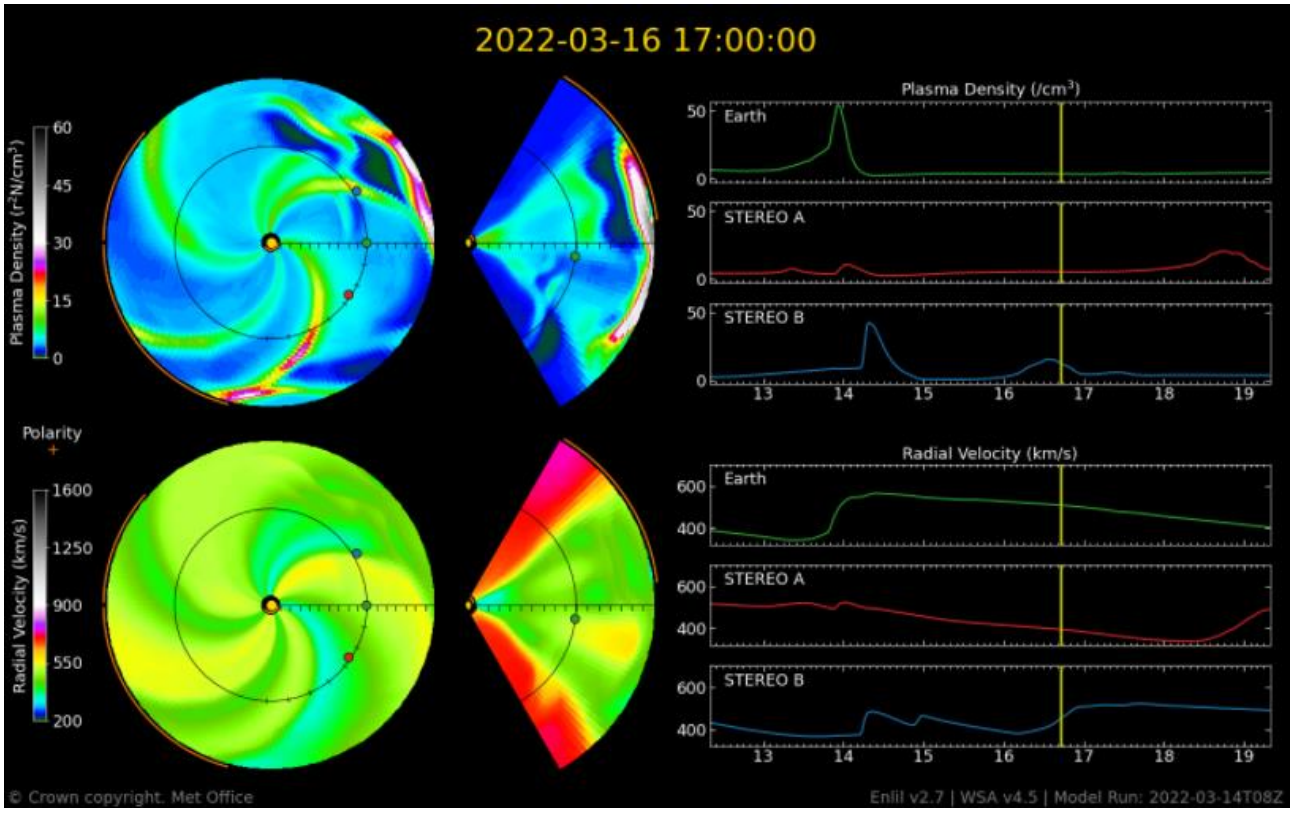
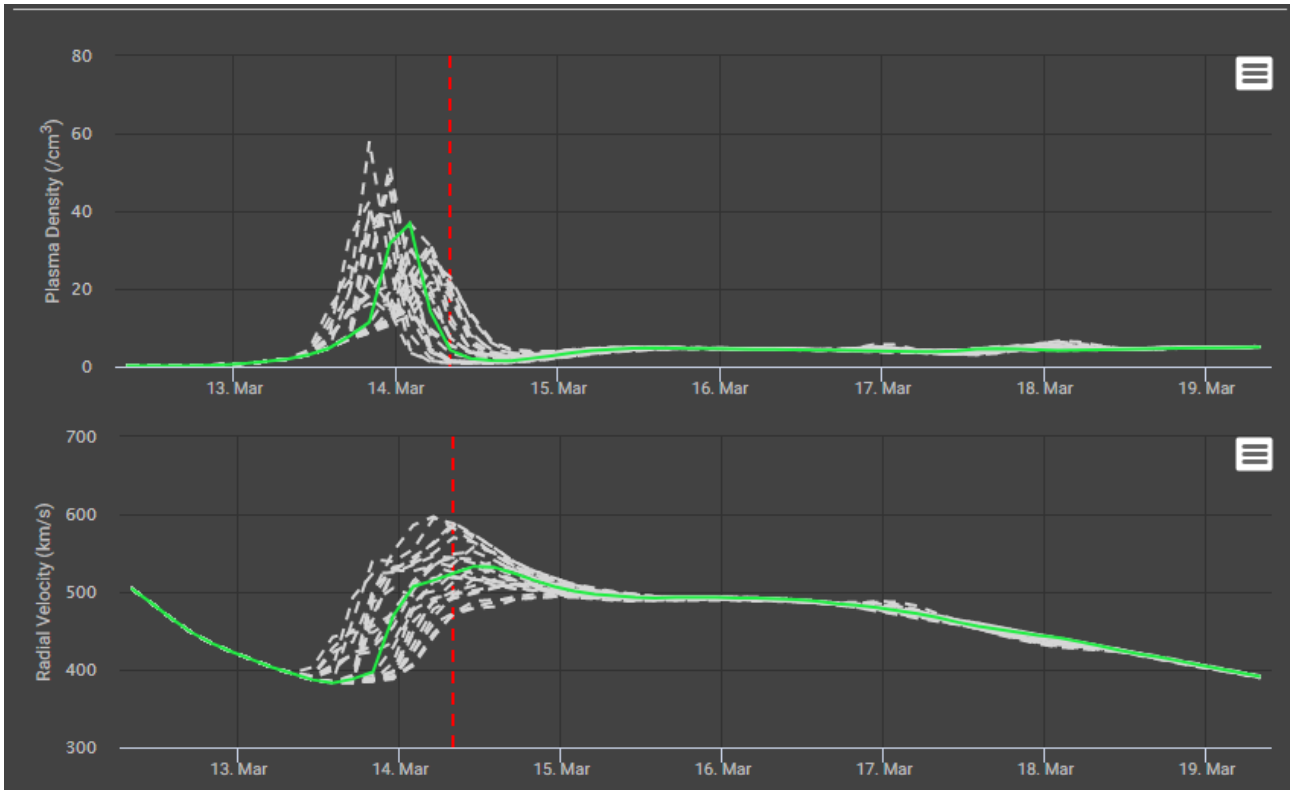
Figure 2: Enlil and ensemble showing just a very slight chance of a weak glancing blow on Day 4 (17 March).





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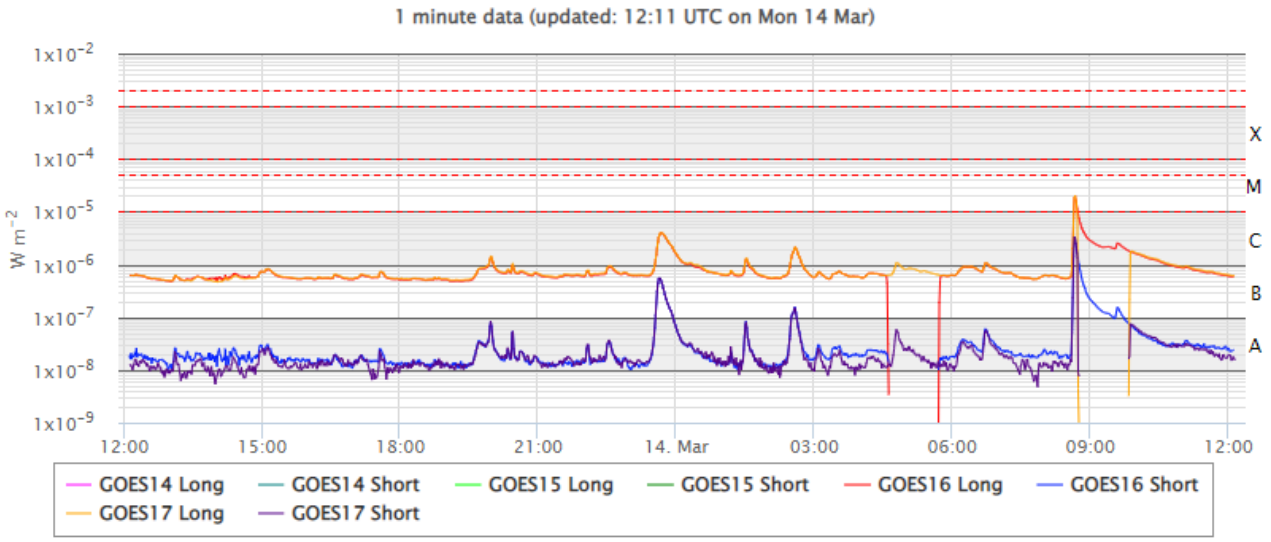
Radio Blackouts - X-Ray Flares:
There are currently five numbered sunspot regions on the visible disc, with Moderate solar activity. The largest flare was an M2 at 14/0840 UTC from AR2965. This region is approaching centre disc in the northern hemisphere, classified Fai/Beta-gamma-delta. It has recently developed a very small delta area in one of the central spots, with the intermediate spots continuing to show rudimentary penumbra. AR2960 is a large Hhx/Alpha spot in the southwest but has remained stable, with no flare activity observed. The other spots are all small and simple unipolar regions.

Activity is expected to be Low, with a chance of increasing to Moderate again from any M-flares, with the main risk from AR2965.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	25	25	25	25
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: X-ray flare trace showing recent M-flare from AR2965.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (10MeV) measured at GOES 16 is currently at background levels. There is just a very slight chance of an S1/Minor radiation storm in the event of larger flares occurring, mainly from AR2965.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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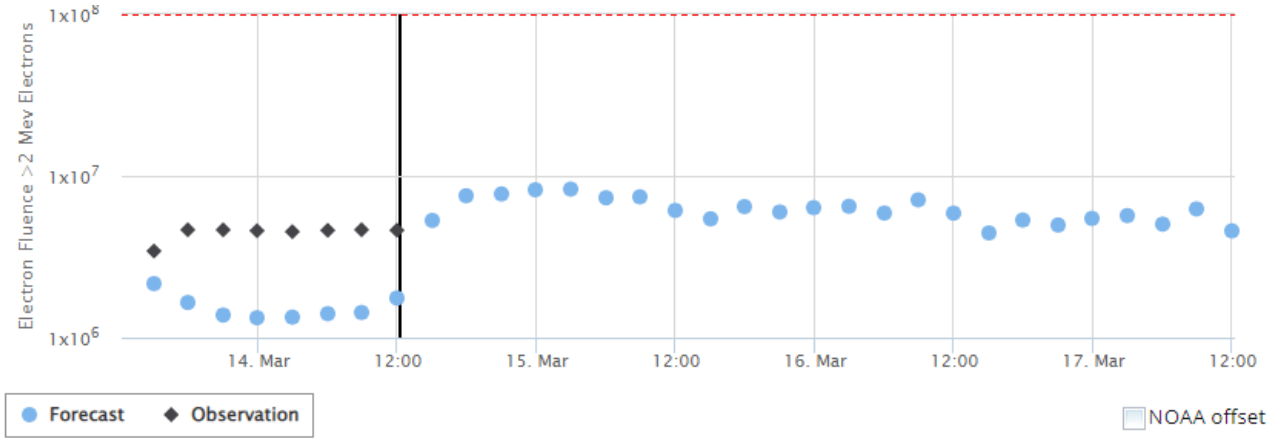
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed at GEO by GOES-16 is currently at background levels. The recent CME arrival has suppressed electron flux levels, but some charging may have occurred from the higher wind speeds, although these higher wind speeds were relatively short lived. Therefore a rise in electron levels is possible from Day 2 (15 Mar) onwards, although some uncertainty remains as to the level of charging we may have experienced.

The associated 24 hour electron fluence is likely to follow a rising trend if we see an electron response to this CME, but currently confidence is low as to whether it is likely to reach the Active (1e8 integrated pfu) threshold, with a chance on Days 3 and 4 (16-17 Mar).

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	20	30	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: REFM is currently showing a fairly level trend in fluence. This may not be fully accounting for recent CME effects however.



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